

DOCUMENT RESUME

ED 307 498

CE 052 627

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TITLE TV Trouble-Shooting Manual. Volumes 3-4. Part 1:
Block Diagram of Colour TV Receiver and Signal Flow.
Student and Instructor's Manuals.
INSTITUTION International Labour Office, Islamabad (Pakistan).
Asian and Pacific Skill Development Programme.
REPORT NO ISBN-92-2-106777-7; ISBN-92-2-106778-5
PUB DATE 88
NOTE 46p.; For related manuals, see CE 052 625-633.
AVAILABLE FROM ILO Publications, International Labour Office,
CH-1211 Geneva 22, Switzerland (\$3.00 each volume;
complete set: ISBN-92-2-106780-7).
PUB TYPE Guides - Classroom Use - Materials (For Learner)
(051) -- Guides - Classroom Use - Guides (For
Teachers) (052)
EDRS PRICE MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS Adult Vocational Education; *Electric Circuits;
*Equipment Maintenance; Postsecondary Education;
*Repair; *Television Radio Repairers; *Video
Equipment
IDENTIFIERS *Troubleshooting

ABSTRACT

These volumes are, respectively, the self-instructional student manual and the teacher manual that cover the first set of training topics in this course for television repair technicians. Both volumes contain the following two sections: (1) Functional Block Diagram of a Colour TV Receiver, including information on the video reproduction circuit, the chrominance or chroma signal reproduction circuit, the synchronization and deflection circuits, and the sound reproduction circuit; and (2) Colour TV Circuits and Signal Processing, including information on the video reproduction circuit, the synchronization and deflection circuits, the color reproduction circuit, and the sound reproduction circuit. Circuit diagrams and functional block diagrams are included. The only difference between the student and instructor manuals seems to be that the narrative in the student volume appears in numbered paragraphs that are one or two sentences long, and the same sentences are grouped to form longer (and, consequently, fewer) paragraphs without numbers in the instructor manual. (CML)

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TV TROUBLE-SHOOTING MANUAL

VOLUMES 3-4

Part 1: Block Diagram of Colour TV Receiver
and Signal Flow

Student and Instructor's Manuals

Asian and Pacific Skill Development Programme
Islamabad, Pakistan

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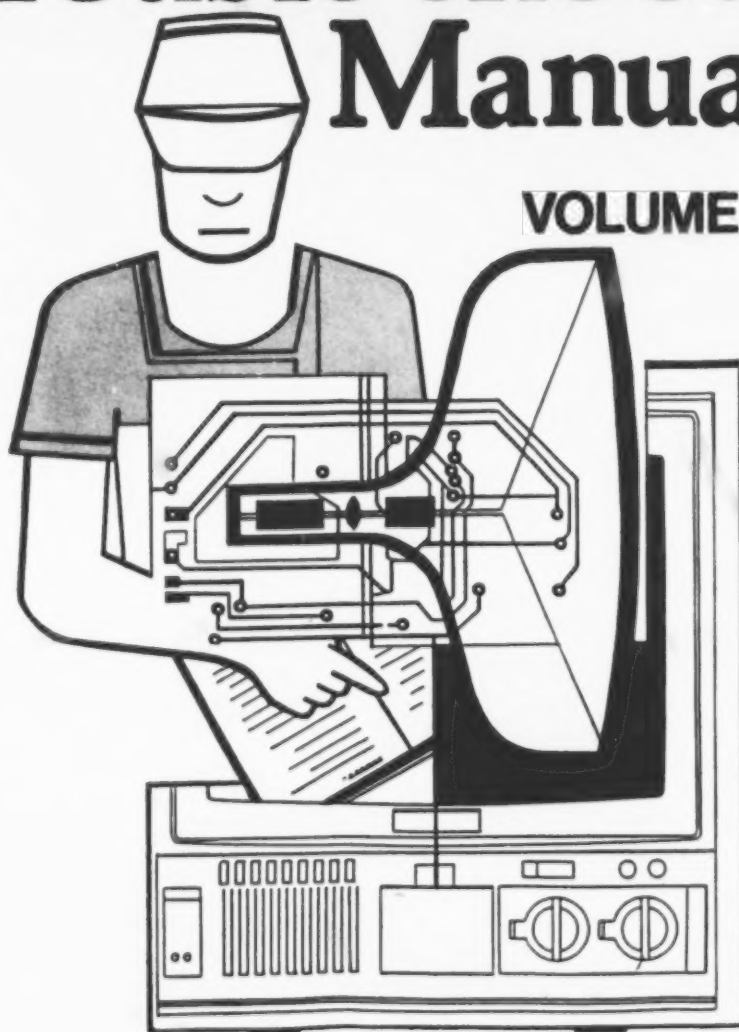
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TV Trouble-shooting Manual

VOLUME



BY MASA AKI MUKAI AND RYOZO KOBAYASHI

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TV Trouble-shooting Manual, Vol 3, by Masaaki Mukai and Ryoza Kobayashi.
APSDP, Islamabad, Pakistan, 1988, vi+15pp., Price US\$ 3.00.

Teaching and training material for the training of television set technicians —
Explains structure and function of a video reproduction circuit, chrominance
signal reproduction unit, synchronisation and deflection circuit, sound reproduction
circuit, sync and deflection circuit, colour and sound reproduction circuits.
Block diagrams.

/APSDP PUB/ /TEACHING AND TRAINING MATERIAL/ /TELEVISION SET/ /TECH-
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ISBN for the complete set: 92-2-106780-7

ISBN for this volume: 92-2-106777-7

TV Trouble-shooting Manual

VOLUME 3

Part 1: Block diagram of colour
TV receiver and signal flow

BY MASA AKI MUKAI AND RYOZO KOBAYASHI



ASIAN AND PACIFIC SKILL DEVELOPMENT PROGRAMME
INTERNATIONAL LABOUR OFFICE
ISLAMABAD, PAKISTAN, 1988

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ISBN for the complete set: 92-2-106780-7

ISBN for this volume: 92-2-106777-7

First published 1988

Designed by West Design Studio, Manila

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Printed by Pictorial Printers Ltd., Islamabad, Pakistan

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Part 1: Block diagram of colour TV receiver and signal flow

1 FUNCTIONAL BLOCK DIAGRAM OF A COLOUR TV RECEIVER

- 1 Figure 1-1a (see page 2) shows a block diagram of a colour TV receiver set.
- 2 A colour TV generally consists of video reproduction, colour or chroma signal reproduction, synchronisation and deflection, sound reproduction, and power-supply circuits. It also includes a speaker and a picture tube for sound and picture reproductions.

Video reproduction circuit

- 3 The video reproduction circuit consists of the tuner, VIF (Video Intermediate Frequency) amplifier, video detector and video amplifier circuits. These circuits process the RF signal of TV stations into a composite video signal.

Chrominance or chroma signal reproduction circuit

- 4 Chrominance indicates both hue and saturation of colour. It includes all colour information, without brightness. This circuit separates the colour signals from the composite video signal and then processes the colour signals into three primary colour signals (red, blue and green) which will drive the colour cathode-ray tube (CRT).

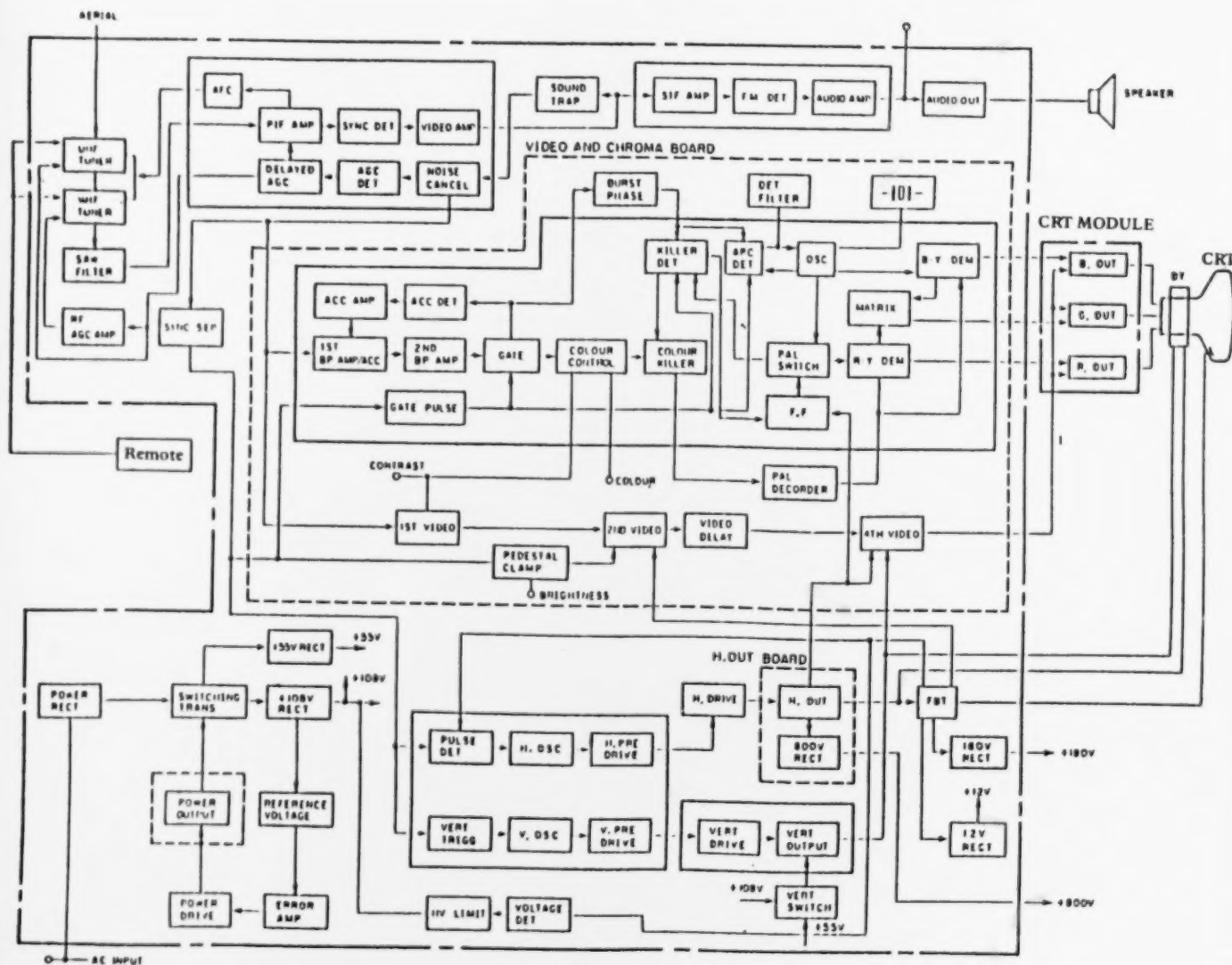


Figure 1-1a
Functional block diagram of a colour TV receiver set

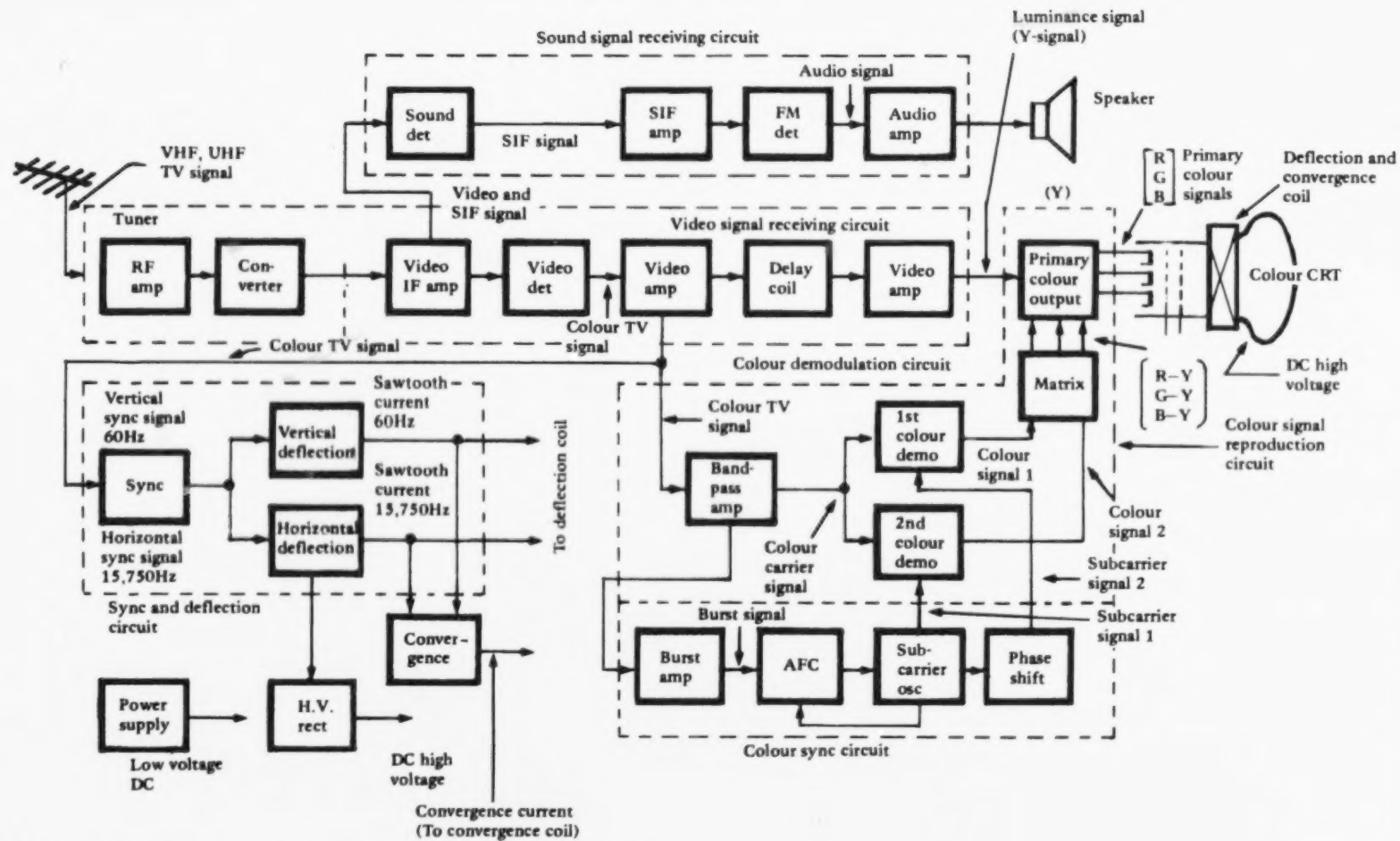


Figure 1-1b
Functional block diagram of colour television receiver and its signal flow

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Synchronisation and deflection circuit

- 5 The sync (synchronisation) circuit separates the sync signals from the composite video signal.
- 6 The sync signals are needed to synchronise the deflection circuits with the scanning in the transmitting station for proper image reproduction on the screen.
- 7 The deflection circuits deflect the electron beams in order to scan the entire screen.

Sound reproduction circuit

- 8 This circuit separates the sound signal from the composite video signal in the VIF circuit.
- 9 The sound signal is amplified by the SIF (Sound Intermediate Frequency) amplifier circuit and then detected by an FM detector producing the audio signal.
- 10 The audio signal is amplified by the audio amplifier circuit to drive the speaker/s of the TV receiver.
- 11 The above is just a brief discussion of the block circuits of a colour TV receiver set. A more detailed explanation is given in the succeeding paragraphs.

2 COLOUR TV CIRCUITS AND SIGNAL PROCESSING

1 Video reproduction circuit

Tuner

- 1 Figure 1-2 shows a block diagram of a tuner. It consists of an RF amplifier, a mixer and a local oscillator circuit.
- 2 The tuner amplifies the tuned-in RF signal of the TV station and converts it into an IF signal.
- 3 The RF amplifier circuit amplifies the RF signal (TV station signal), which has a bandwidth of 6 MHz. The amplified RF signal is coupled to the mixer circuit. The RF amplifier circuit should have a flat frequency response.
- 4 Besides amplifying the RF signal, the RF amplifier circuit improves the S/N (signal-to-noise) ratio of the RF signal.
- 5 Another function of the RF amplifier circuit is to serve as a buffer between the antenna and the local oscillator circuit. This prevents the local oscillator signal from being radiated by the antenna, which causes interference in nearby TV sets.
- 6 The local oscillator and the mixer circuits are usually combined in one stage and called the Frequency Converter.
- 7 The local oscillator circuit generates an unmodulated continuous wave (CW) signal to beat with the RF signal in the mixer circuit to produce a VIF signal.
- 8 The frequency of the oscillator output signal is unique for each TV station. Its frequency is always 45.75 MHz or 41.25 MHz above the picture or sound signal carriers of the RF signal, respectively. This ensures a VIF signal frequency equal to all channels.
- 9 Thus, the VIF signal at the output of the mixer circuit always consists of a 45.75 MHz and 41.25 MHz picture and sound signal carriers, respectively. These frequencies are the difference between the frequencies of the local oscillator output and the RF signal carriers.

10 Figure 1-3 shows the signal flow and the frequencies of the respective signals in the tuner circuit.

11 A drift in the local oscillator frequency will cause a drift in the IF frequencies. This reduces the quality in reproducing the image and sound. An AFT (Automatic Frequency Control) circuit is used to stabilise the local oscillator frequency.

Figure 1-2

Functional block diagram of a tuner circuit

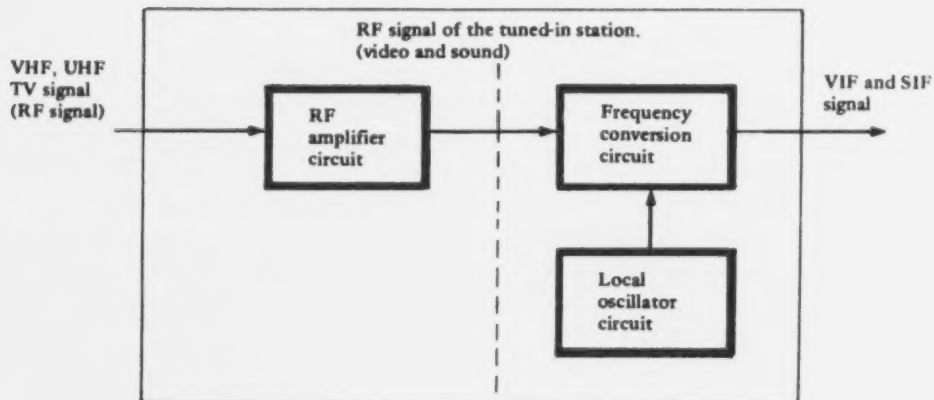
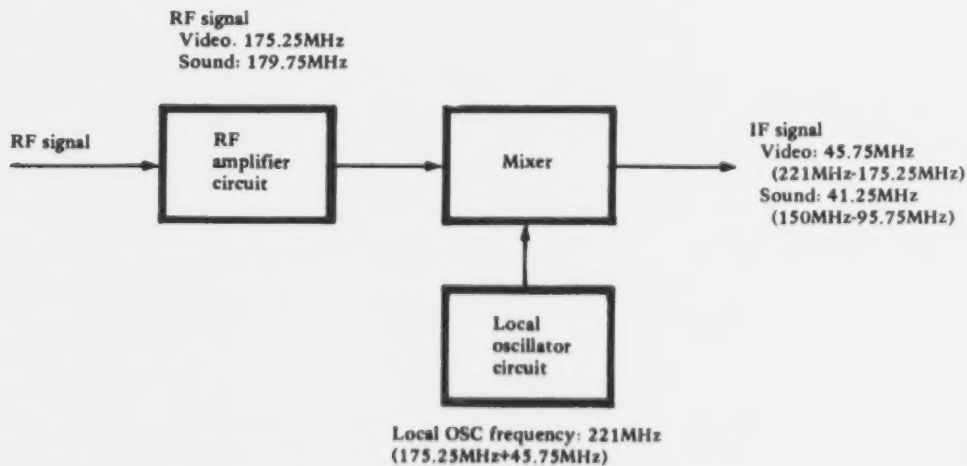


Figure 1-3

TV signal process in a tuner circuit



VIF amplifier circuit

12 The VIF amplifier circuit amplifies the VIF signal from the output of the mixer circuit. It provides the necessary gain and selectivity.

13 Figure 1-4 shows the ideal frequency response of the VIF amplifier circuit. Note that it has a constant amplification within the bandwidth of the video signal and a high attenuation at the neighbouring frequencies, which is sharp at the corner frequencies.

14 To get this frequency response, the input and output stages of the VIF amplifier are designed to have high selectivity and the middle stages are designed to have a wide band amplification. The number of stages in the VIF amplifier circuit ranges usually from three to four.

15 The VIF amplifier has a usual gain of 1,000. Such a high gain is necessary, since the VIF signal is distributed to many circuits, as shown in Figure 1-5.

16 The VIF signal supplies not only the video detector circuit but also the AFC (Automatic Frequency Control) circuit in the local oscillator and the 4.5 MHz sound detector circuit.

17 The overall gain of the VIF circuit, as well as the RF amplifier circuit, is controlled by the AGC (Automatic Gain Control) circuit.

18 The AGC circuit maintains the output of the VIF amplifier circuit at a constant level regardless of strength variations in the signals in the antenna.

Figure 1-4
Ideal overall characteristics of IF circuit

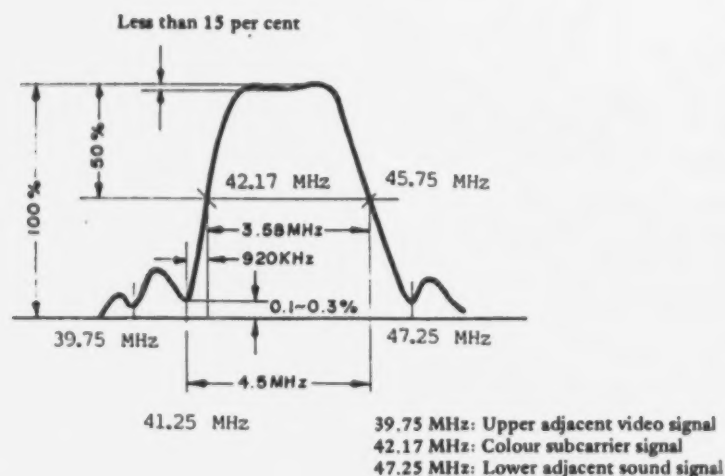
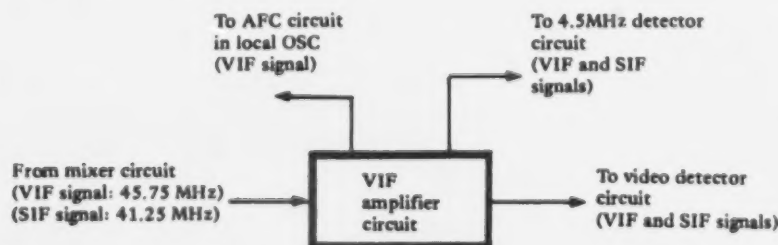


Figure 1-5
Signal distribution at VIF amplifier circuit



Video detector circuit

19 The video detector detects the amplified VIF signals and produces composite video signal as output. A diode with a good linearity and less distortion is used as a video detector.

20 A filter circuit specially designed to eliminate noise is also included in the video detector circuit.

21 The polarity of the composite video signal is either positive or negative, as shown in Figure 1-6, depending on the connection of the detector diode.

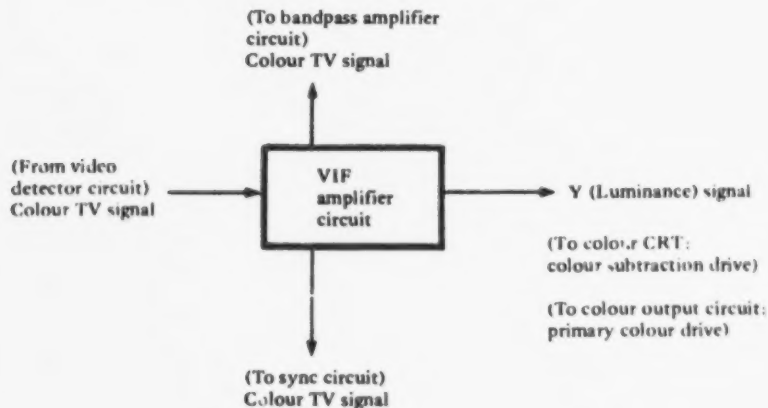
22 The number of the stages in the video amplifier and the type of CRT drive (grid or cathode) being used determine the necessary polarity of the video detector output.

Figure 1-6
Video signals

**Video amplifier circuit**

23 The video amplifier circuit usually consists of three to four stages. Besides amplifying the video signal, it distributes the composite video signal to the chroma and sync circuits, as shown in Figure 1-7.

Figure 1-7
Signal process in video amplifier circuit



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24 The composite colour video signal contains both the luminance (Y) and the chrominance (C) signal. The maximum frequency swing of the AC video signal component is 4 MHz above the DC video signal component.

25 Ideally, the video amplifier circuit should have a constant gain within the 4 MHz band of the video signal.

26 However, to avoid beat interference with the 3.8 MHz chroma signal, the video amplifier circuit is designed to have the frequency response shown in Figure 1-8 wherein the video signal is cut off at 3.2 MHz.

27 This kind of response improves the poor resolution of the image which is caused by the structure of the CRT (beam aperture characteristic). Since the circuit cuts off at 3.2 MHz, the chroma signal is attenuated and thus the output effectively only consists of the Y signal.

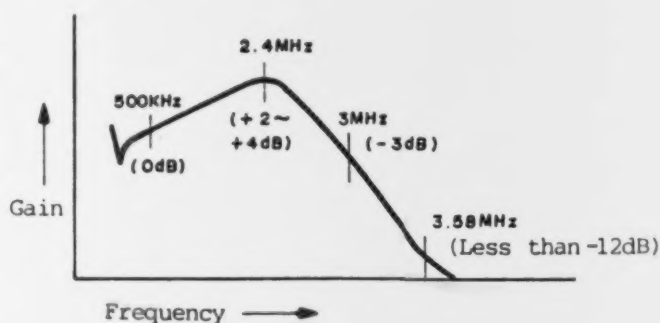
28 Furthermore, the video amplifier circuit has a delay line. The need for a delay line arises due to the difference in the bandwidth of the video amplifier and the colour circuits.

29 The video amplifier has a wider bandwidth (more resistive) than the tuned colour circuits. A more resistive circuit means less delay.

30 Since the Y signal encounters less delay than the chroma signal, it reaches the colour CRT first.

31 If the Y signal arrives ahead of the chroma signal at the CRT, colour fringing occurs. Thus, a delay line is necessary to delay the Y signal to synchronise its arrival with the chroma signal at the CRT.

Figure 1-8
Frequency response in
video amplifier circuit



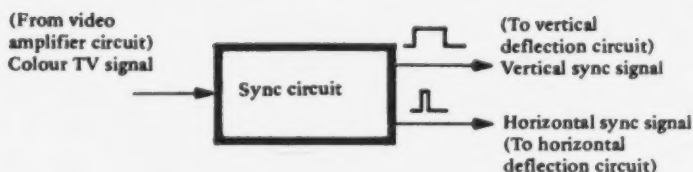
2 Sync and deflection circuits

Sync circuit

- 1 As shown in Figure 1-9, the sync signal is taken out from the composite video signal at the sync separator circuit.
- 2 An amplitude separator circuit is used in taking out the sync signal. The sync signal contains the horizontal and the vertical sync signals.
- 3 After being separated from the composite video signal, the sync signals are further separated into horizontal and vertical sync signals by a frequency separator circuit.
- 4 Then, horizontal and vertical sync signals are distributed to succeeding horizontal AFC circuits and to the vertical deflection circuits, respectively, producing a synchronised image on the screen.

Figure 1-9

Signal process in synchronisation circuit



Deflection circuit

- 5 The deflection circuit consists of two independent circuits: the horizontal and the vertical deflection circuits. Each circuit has its own sawtooth-wave generator, amplifier and output circuits.
- 6 The deflection circuit produces the horizontal and the vertical sawtooth currents for the horizontal and the vertical deflection coils, respectively.
- 7 The horizontal and the vertical sync signals control the horizontal and the vertical sawtooth currents, respectively, for proper synchronisation in the scanning of the image on the screen.

Vertical deflection circuit

- 8 The vertical oscillator circuit (sawtooth-wave generator circuit) generates a 60 Hz sawtooth current. This current is then amplified by the vertical amplifier circuit to a strength sufficient to deflect the electron beam in the CRT.
- 9 The scanning of the beam should be linear to produce an undistorted image. Hence, the sawtooth current flowing through the deflection coils should have good linearity. The circuit should be properly designed to produce a sawtooth current that meets this requirement.

10 TV TROUBLE-SHOOTING MANUAL

Horizontal deflection circuit

10 As shown in Figure 1-10, the horizontal deflection circuit produces a 15,750 Hz sawtooth current. This current is supplied to the horizontal deflection coil.

11 Unlike vertical synchronisation, horizontal synchronisation is easily distorted by noise pulses. The horizontal AFC (Automatic Frequency Control) circuit is used to prevent noise pulses from disturbing the horizontal sync circuit.

12 The horizontal AFC circuit compares the frequency of the horizontal sawtooth current and the horizontal sync signals. If any difference is detected, it automatically adjusts the horizontal oscillator frequency to the frequency of the horizontal sync signal.

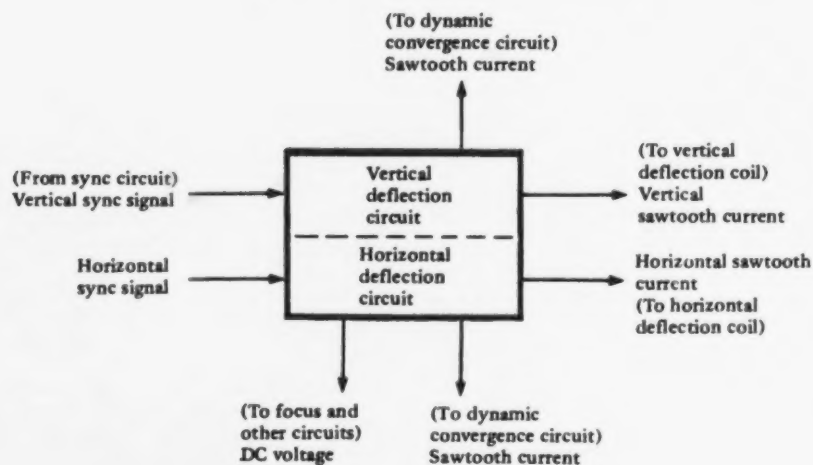
13 The power requirement of the horizontal deflection circuit is about 100 times greater than the vertical deflection circuit.

14 A high-performance power circuit using a combination of a high-power output transistor and a damper diode is used to improve the efficiency and to meet the power requirement of the horizontal deflection circuit.

15 The flyback transformer (FBT) in the horizontal deflection circuit serves as a high-voltage supply for the anode of the colour CRT and as a power supply for several other circuits.

Figure 1-10

Signal process in deflection circuit



3 Colour reproduction circuit

1 As shown in Figure 1-1b, the colour reproduction circuit consists of two sections: the colour demodulator and the colour sync circuit.

2 The colour reproduction circuit does the following functions:

- a it takes out the colour signal from the composite colour video signal
- b it demodulates and amplifies the chroma signal
- c it supplies the colour or the colour-subtraction signal to the CRT

Colour demodulator section

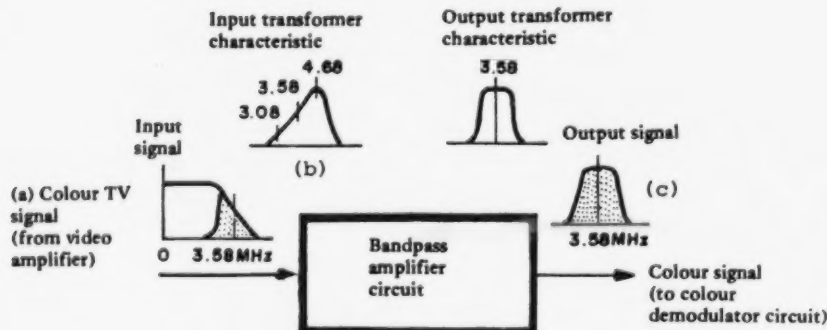
3 The colour or chroma demodulator includes the bandpass amplifier, the chroma demodulator and the chroma amplifier circuits.

Bandpass amplifier circuit

- 4 The bandpass amplifier consists of one or two stages tuned to 3.58 MHz with a bandwidth of ± 500 kHz.
- 5 The input signal to the bandpass amplifier circuit is the composite colour video signal taken from the output of the video pre-amplifier circuit.
- 6 Since this amplifier is tuned to 3.58 MHz, its output consists only of the amplified 3.58 MHz chroma and burst signals.
- 7 The output is coupled to the chroma demodulator and to the burst separator circuits. The chroma demodulator demodulates the colour information for the image; the burst separator takes out the burst signal for the synchronisation of colour.
- 8 Besides amplifying the chroma signal, the bandpass amplifier circuit compensates for the frequency distortion of the chroma signal. This distortion is due to the frequency response of the video amplifier, shown in Figure 1-11(a).
- 9 The video amplifier has higher attenuation at higher frequencies of the composite video signal where the colour information (chroma signal) is located. This results in uneven amplification of the chroma signal contained in the output of the video amplifier.

Figure 1-11

Signal process in bandpass amplifier circuit



10 Since the input signal of the bandpass amplifier is the output of the video amplifier, the bandpass amplifier uses a special input transformer tuned to 4.68 MHz with a frequency response shown in Figure 1-11(b). As shown in Figure 1-11(c), the uneven amplification of the chroma signal is compensated by this transformer.

11 The bandpass amplifier circuit is also associated with the ACC (Automatic Colour Control) and colour killer circuits. The ACC automatically controls the saturation of the colour; the colour killer circuit disables the chroma-reproduction circuit when a black-and-white transmission is received.

Chroma demodulator and amplifier circuit

12 The chroma signal is transmitted with its carrier signal suppressed at the transmitter. With this type of transmission, the chroma signal cannot be demo-

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ulated by an ordinary detector circuit. A special kind of demodulator circuit is needed to demodulate the colour information from the chroma signal.

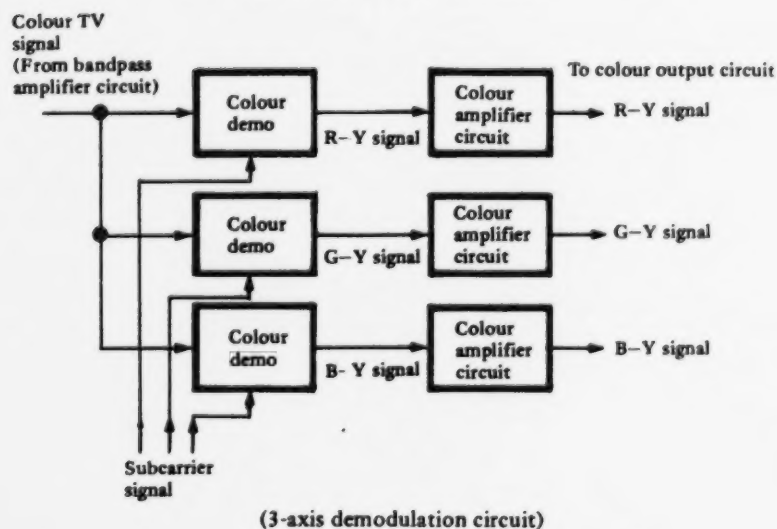
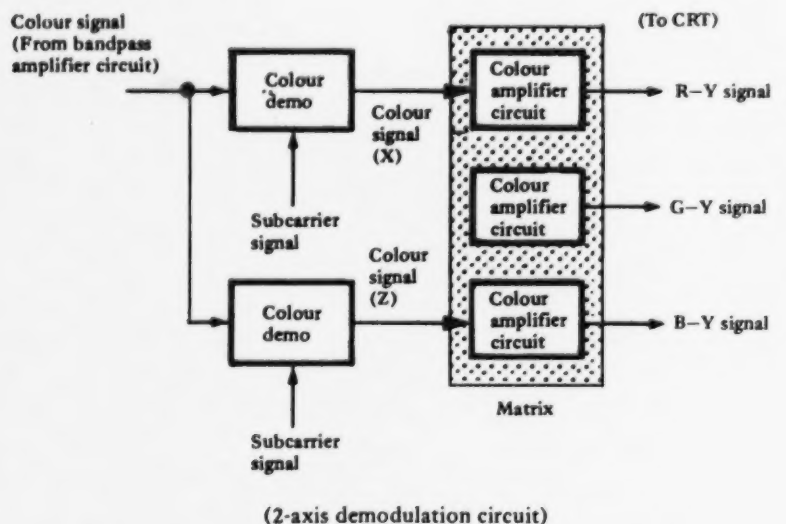
13 The two kinds of chroma demodulator circuits commonly used are the 2-axis (X, Z) demodulator and the 3-axis (R-Y, G-Y and B-Y) demodulator circuits.

14 The functional block diagram of these demodulator circuits is shown in Figure 1-12. The 2-axis demodulator uses a matrix circuit whose output is the three subtraction signals (R-Y, G-Y, B-Y). These subtraction signals are amplified and supplied to the colour CRT.

15 There are two methods of supplying the colour subtraction signals to the colour CRT. One is by supplying the signals directly to the CRT and the other is by mixing the subtraction signals with the luminance signal that is supplied to the CRT.

Figure 1-12

Functional block diagram of a colour demodulator circuit



Colour synchronisation section

- 16 The colour or chroma sync section processes the burst signal and re-generates the colour subcarrier signal suppressed during transmission.
- 17 The phase of the re-generated subcarrier signal is synchronised to the phase of the colour burst signal.
- 18 The phase of the subcarrier signal with respect to the burst signal determines the hue of the demodulated colour signal.
- 19 The colour sync section consists of the burst amplifier and the colour oscillator circuit.

Burst amplifier circuit

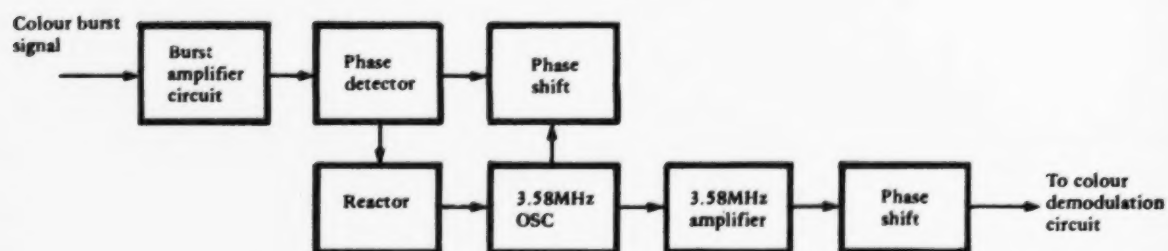
- 20 The burst amplifier circuit amplifies and separates the burst signal from the chroma signal. The chroma and the burst signals both have a frequency of 3.58 MHz.
- 21 However, the burst signal is present only during the horizontal blanking time. Thus, by keying on the burst amplifier circuit only during the horizontal blanking time with horizontal retrace pulses, the burst signal is amplified and separated from the chroma signal.
- 22 The separated and amplified burst signal is used to synchronise the output of the colour subcarrier generator circuit with the burst signal.

Colour subcarrier generator circuit

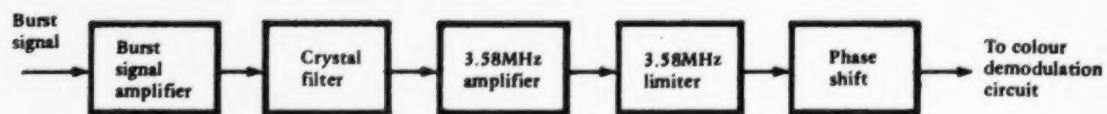
- 23 The colour subcarrier generator circuit re-generates the colour subcarrier signal (3.58 MHz, continuous wave) with its phase synchronised with the phase of the colour burst signal.
- 24 The colour subcarrier generator circuits commonly used are the APC (Automatic Phase Control), the crystal filter and the burst injection lock circuits. These three kinds of circuits are shown in Figure 1-13.
- 25 The APC type is often used due to its high-precision performance. A phase-shifting circuit is placed at the output of the circuit to control the phase of the colour subcarrier signal.

Figure 1-13

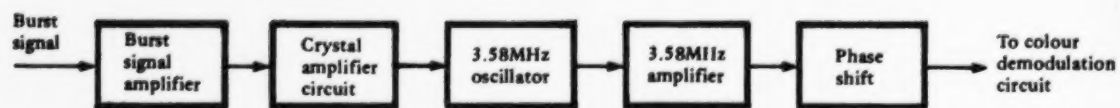
Functional block diagram of a colour synchronisation circuit



(a) APC circuit



(b) Crystal-filter circuit



(c) Burst signal injection lock circuit

4 Sound reproduction circuit

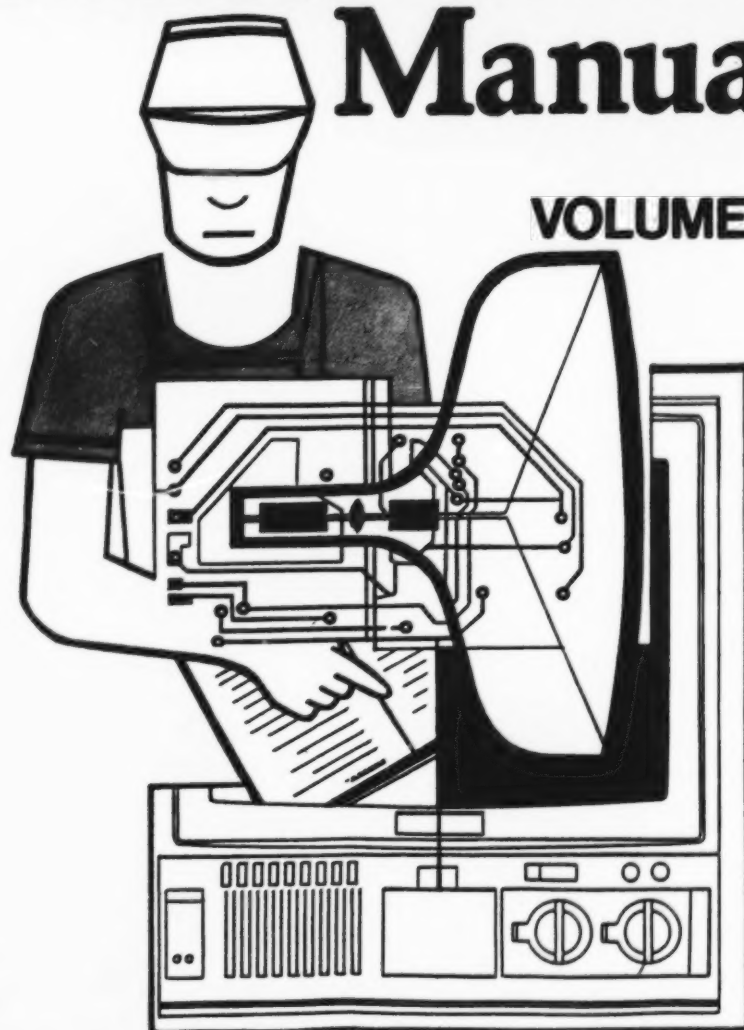
- 1 The block diagram of a sound reproduction circuit is shown in Figure 1-1B.
- 2 Note from the figure that the VIF signals are supplied to the 4.5 MHz detector circuit. The output of the 4.5 MHz detector is the receiver's second IF signal, the 4.5 MHz SIF (sound IF) signal. 4.5 MHz is the difference between the video and the sound carrier frequencies.
- 3 Since the sound signal is attenuated in the VIF amplifier circuit to prevent interference with the video signal, the 4.5 MHz sound signal has to be amplified by the 4.5 MHz SIF amplifier circuit.
- 4 The amplified SIF signal is fed to an FM detector, since the SIF is a frequency-modulated (FM) signal.
- 5 The output of the FM detector is an audio signal.
- 6 The audio signal is then amplified by an AF (audio frequency) amplifier to a strength necessary to drive the speaker for sound reproduction.



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ISBN for this volume: 92-2-106777-7
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BY MASAOKI MUKAI AND RYOZO KOBAYASHI

TV Trouble-shooting Manual, Vol 4, by Masaaki Mukai and Ryoza Kobayashi
APSDEP, Islamabad, Pakistan, 1988, iv+15pp., Price US\$ 3.00.

Trainers Manual for the training of television set technicians – Explains structure and function of a video reproduction circuit, chrominance signal reproduction unit, synchronisation and deflection circuit, sound reproduction circuit, sync and deflection circuit, colour and sound reproduction circuits Block diagrams.

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/TRAINER/ /TECHNICIAN/

ISBN for the complete set: 92-2-106780-7
ISBN for this volume: 92-2-106778-5

TV Trouble-shooting Manual

VOLUME 4

**Part 1: Block diagram of colour
TV receiver and signal flow
Instructor's manual**

BY MASAACKI MUKAI AND RYOZO KOBAYASHI



**ASIAN AND PACIFIC SKILL DEVELOPMENT PROGRAMME
INTERNATIONAL LABOUR OFFICE
ISLAMABAD, PAKISTAN, 1988**

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ISBN for the complete set: 92-2-106780-7

ISBN for this volume: 92-2-106778-5

First published 1988

Designed by West Design Studio, Manila

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	Sync and deflection circuits	9
	Colour reproduction circuit	10
	Sound reproduction circuit	15

Part 1: Block diagram of colour TV receiver and signal flow. Instructor's manual

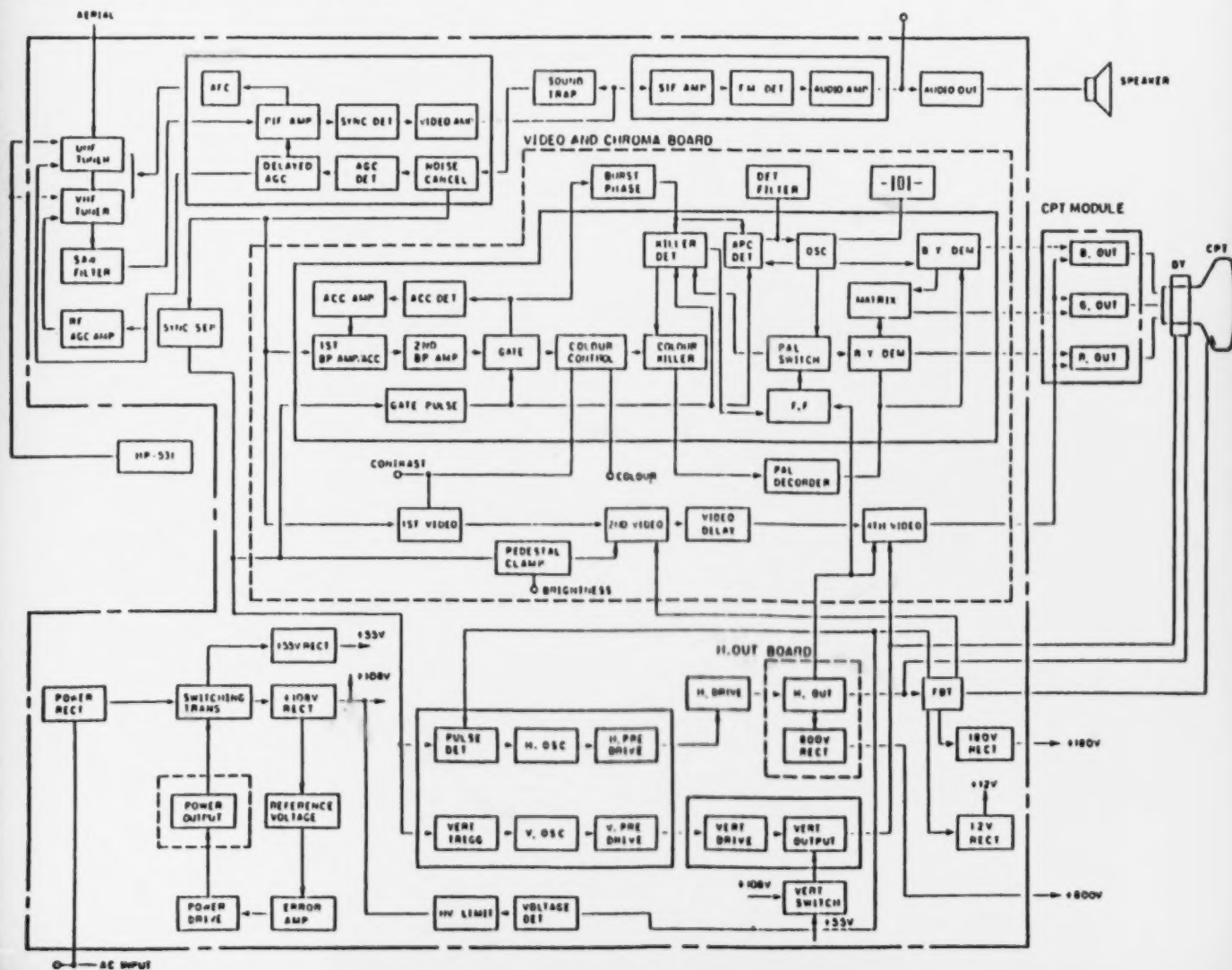
Functional block diagram of a colour TV receiver

Figure 1-1 shows a typical block diagram of a colour TV receiver set. A colour TV generally consists of the following: video reproduction, colour or chroma signal reproduction, synchronisation and deflection, sound reproduction and power-supply circuits. Also included are a speaker for sound reproduction and a picture tube for picture reproduction.

Video-reproduction circuit. This consists of the tuner, VIF (video intermediate frequency) amplifier, video detector and the video amplifier circuits. These circuits process the RF signal of TV stations into a composite video signal.

Chrominance or chroma signal reproduction circuit. This separates the colour signals from the composite video signal and then processes the colour signals into three primary colour signals (red, blue and green) which will drive the colour CRT.

Figure 1-1
Functional block diagram of a colour TV receiver set



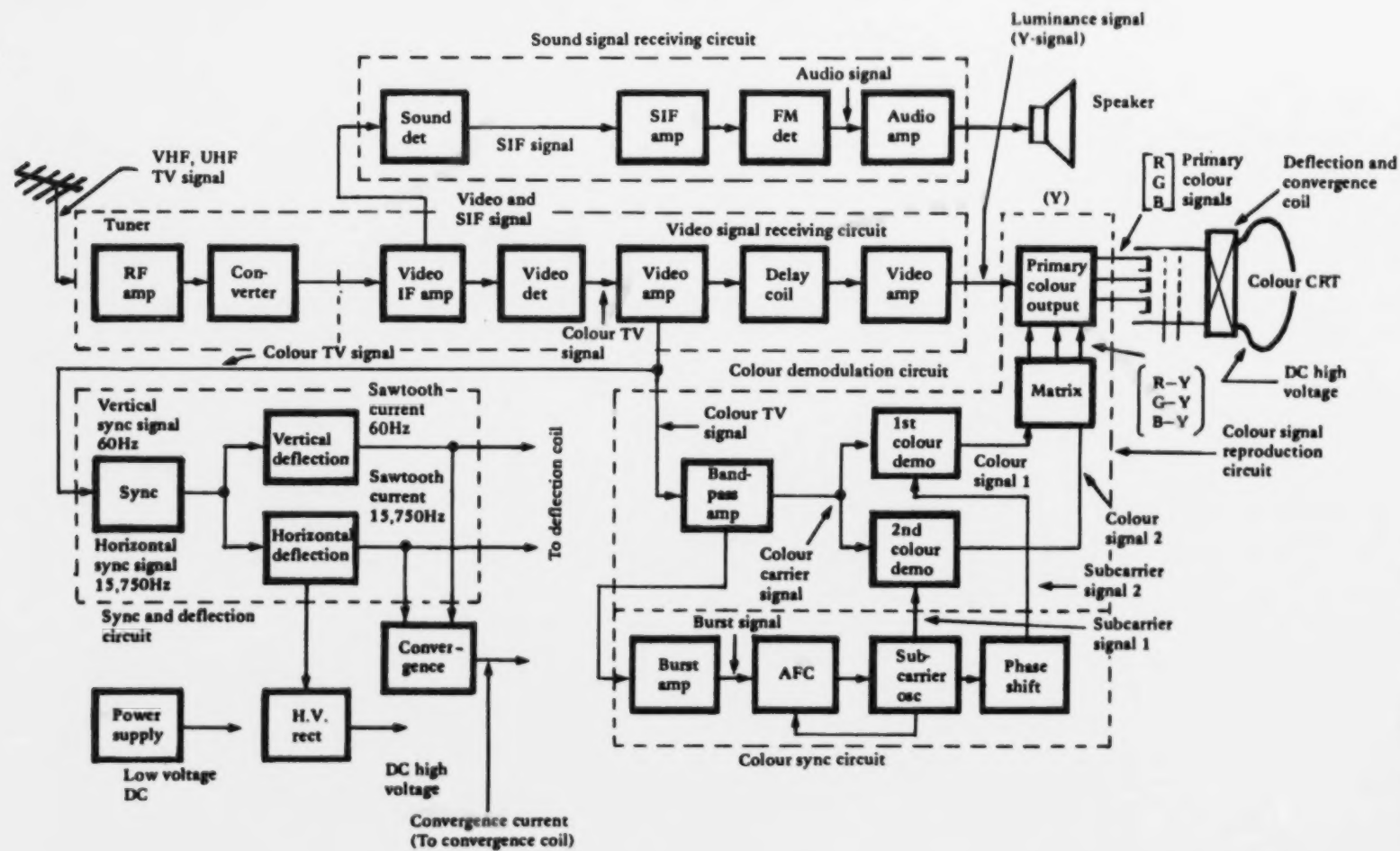


Figure 1-1b
Functional block diagram of colour
television receiver and its signal flow

Synchronisation and deflection circuits. The sync (synchronisation) circuit separates the sync signals from the composite video signal. The sync signals are needed to synchronise the deflection circuits with the scanning in the transmitting station for proper image reproduction on the screen. The deflection circuits deflect the electron beams that scan the entire screen.

Sound reproduction circuit. This circuit separates the sound signal from the composite video signal in the VIF circuit. The sound signal is amplified by the SIF (sound intermediate frequency) amplifier circuit and then detected by an FM detector, the audio signal. The audio signal is amplified by the audio amplifier circuit to drive the speaker(s) of the TV receiver.

The above is just a brief discussion of the block circuits of a colour TV receiver set. A more detailed explanation is given in the succeeding paragraphs.

Colour TV circuits and signal processing

Video reproduction circuit

Tuner. Figure 1-2 shows a block diagram of a tuner. It consists of an RF amplifier, a mixer and a local oscillator circuit. The tuner amplifies the tune in an RF signal of the TV station and then converts it into an IF signal.

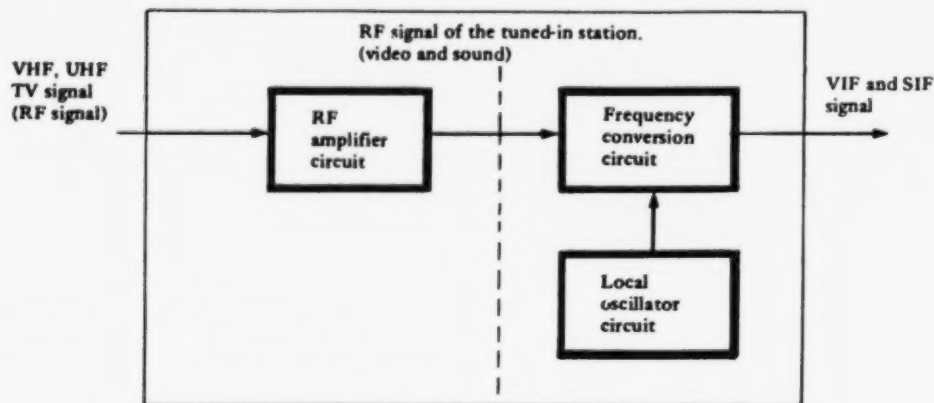
The RF amplifier circuit amplifies the RF signal (TV station signal), which has a bandwidth of 6 MHz. The amplified RF signal is coupled to the mixer circuit. The RF amplifier circuit should have a flat frequency response.

Besides amplifying the RF signal, the RF amplifier circuit improves the signal-to-noise ratio of the RF signal. The RF amplifier circuit also serves as a buffer between the antenna and the local oscillator circuit, preventing the local oscillator signal from being radiated by the antenna. A radiated oscillator signal causes interference in nearby TV sets.

The local oscillator and the mixer circuits are usually combined in one stage. The combination is called frequency converter.

The local oscillator circuit generates an unmodulated continuous wave (CW) signal, which beats with the RF signal in the mixer circuit to produce a VIF signal. The frequency of the oscillator output signal is different for each TV station. Its frequency is always 45.75 MHz above the picture and 41.25 MHz above the sound signal carriers of the RF signal to ensure a VIF signal frequency equal to all channels.

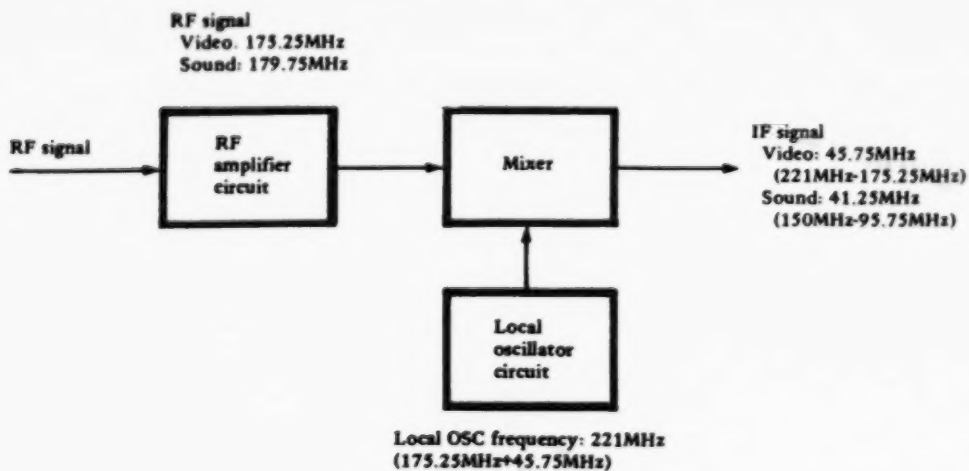
Figure 1-2
Functional block diagram of a tuner circuit



So, the VIF signal at the output of the mixer circuit always consists of a 45.75-MHz picture-signal carrier and 41.25-MHz sound-signal carrier. These frequencies are the difference between the frequencies of the local oscillator output and the RF signal carriers.

Figure 1-3 shows the signal flow and the frequencies of the picture and sound signals in the tuner circuit. A drift in the local oscillator frequency will cause a drift in the IF frequencies. When this happens, the image and sound reproduced are distorted. An AFT (automatic frequency control) circuit is used to stabilise the local oscillator frequency.

Figure 1-3
TV signal process in a tuner circuit



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VIF amplifier circuit. This amplifies the VIF signal from the output of the mixer circuit. It provides gain and selectivity.

Figure 1-4 shows the ideal frequency response of a VIF amplifier circuit. Note that it has a constant amplification within the bandwidth of the video signal and a high attenuation at the neighbouring frequencies which is sharp at the corner frequencies. To get this frequency response, the input and output stages of the VIF amplifier are designed to have high selectivity, while the middle stages are designed to have a wide-band amplification. The number of stages in the VIF amplifier circuit ranges usually from three to four.

The VIF amplifier usually has a high gain of 1,000, which is necessary since the VIF signal is distributed to many circuits as shown in Figure 1-5. The VIF signal is distributed not only to the video-detector circuit but also to the AFC (automatic frequency control) circuit in the local oscillator and to the 4.5-MHz sound-detector circuit.

The overall gain of the VIF circuit, as well as of the RF amplifier circuit, is controlled by the AGC (automatic gain control) circuit. The AGC circuit maintains the output of the VIF amplifier circuit at a constant level regardless of strength variations in the signals in the antenna.

Figure 1-4
Ideal overall characteristics of IF circuit

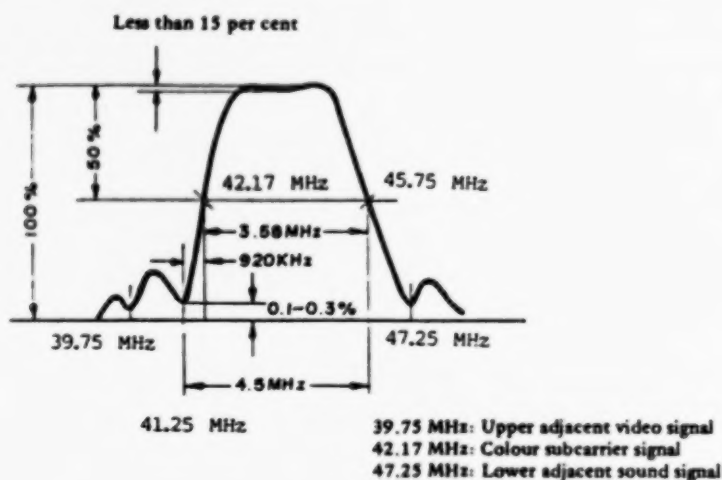
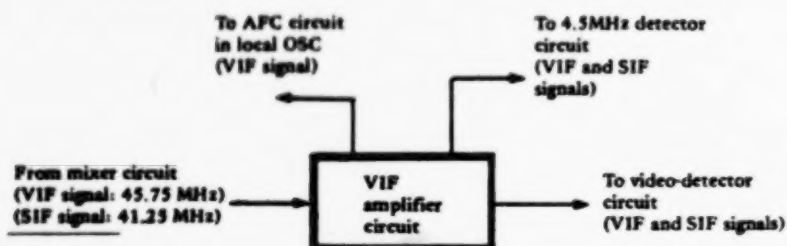


Figure 1-5
Signal distribution at VIF amplifier circuit



Video-detector circuit. The video detector detects the amplified VIF signals and produces the composite video signal. A diode with a good linearity and less distortion is used as a video detector. A filter circuit specially designed to eliminate noise is also included in the video detector circuit.

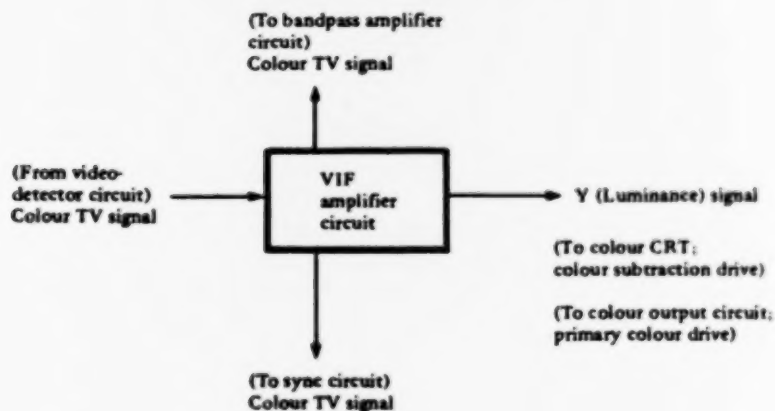
The polarity of the composite video signal is positive or negative as shown in Figure 1-6, depending on the connection of the detector diode. The number of the stages in the video amplifier and the type of CRT drive (grid- or cathode-drive) being used determine the polarity of the video-detector output.

Figure 1-6
Video signals



Video amplifier circuit. This usually consists of three or four stages. Besides amplifying the video signal, it distributes the composite video signal to the chroma and sync circuits as shown in Figure 1-7.

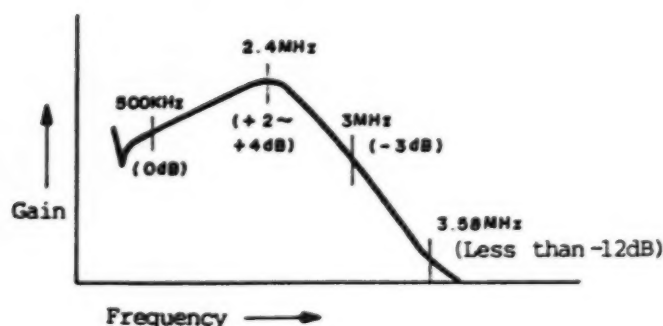
Figure 1-7
Signal process in video amplifier circuit



The composite colour video signal contains the luminance (Y) and the chrominance (C) signal. The maximum frequency swing of the AC video signal component is 4 MHz above the DC video signal component. Ideally, the video amplifier circuit should have a constant gain within the 4-MHz band of the video signal. However, to avoid beat interference with the 3.8-MHz chroma signal, the video amplifier circuit is designed to have the frequency response shown in Figure 1-8 wherein the video signal is cut off at 3.2 MHz. This response improves the poor resolution of the image, which is caused by the structure of the CRT (beam aperture characteristic). Since the circuit cuts off at 3.2 MHz, the chroma signal is attenuated, so the output effectively only consists of the Y signal.

Also, the video amplifier circuit has a delay line. The delay line is needed because of the difference in the bandwidth of the video amplifier and the colour circuits. The video amplifier has a wider bandwidth (more resistive) than the tuned colour circuits. A more resistive circuit means less delay. Since the Y signal encounters less delay than the chroma signal, it reaches the colour CRT first. If the Y signal arrives ahead of the chroma signal at the CRT, colour fringing occurs. Thus a delay line is necessary so that the Y signal can synchronise its arrival with the chroma signal at the CRT.

Figure 1-8
Frequency response in
video amplifier circuit



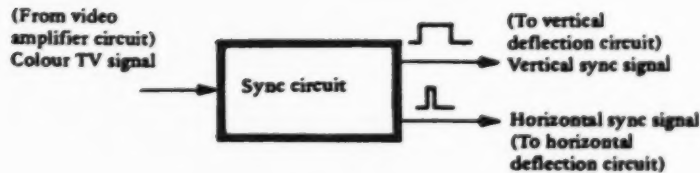
Sync and deflection circuits

Sync circuit. As shown in Figure 1-9, the sync signal is taken out from the composite video signal at the sync separator circuit. An amplitude separator circuit is used to take out the sync signal. The sync signal contains the horizontal and vertical sync signals.

After the separation from the composite video signal, the sync signals are further separated into horizontal and vertical sync signals by a frequency separator circuit. Then, horizontal and sync signals are distributed to succeeding horizontal AFC circuits. Likewise, vertical sync signals are distributed to the vertical deflection circuits for the synchronisation of the image on the screen.

Figure 1-9

Signal process in synchronisation circuit



Deflection circuit. This consists of two independent circuits: the horizontal and vertical deflection circuits. Each circuit has its own sawtooth-wave generator, amplifier and output circuit. The deflection circuit produces the horizontal and the vertical sawtooth currents for the horizontal and the vertical deflection coils, respectively. The horizontal sync signal controls the horizontal sawtooth current; the vertical sync signal, the vertical sawtooth current for proper synchronisation in the scanning of the image on the screen.

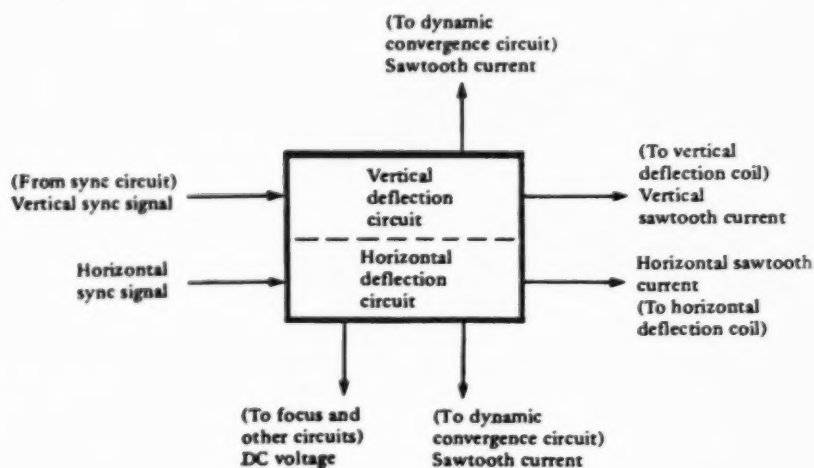
Vertical deflection circuit. The vertical oscillator circuit (sawtooth-wave generator circuit) generates a 60-Hz sawtooth current, which is then amplified by the vertical amplifier circuit to a strength sufficient to deflect the electron beam in the CRT. The scanning of the beam should be linear to produce an undistorted image. So the sawtooth current flowing through the deflection coils should have good linearity. The circuit should be properly designed to produce a sawtooth current that meets this requirement.

Horizontal deflection circuit. As shown in Figure 1-10, the horizontal deflection circuit produces a 15,750-Hz sawtooth current. This sawtooth current is supplied to the horizontal deflection coil.

Unlike the vertical synchronisation, the horizontal synchronisation is easily distorted by noise pulses. The horizontal AFC (automatic frequency control) circuit is used to prevent noise pulses from disturbing the horizontal sync circuit.

The horizontal AFC circuit compares the frequency of the horizontal sawtooth current and the horizontal sync signals. If it detects a difference, the horizontal AFC circuit automatically adjusts the horizontal oscillator frequency to the frequency of the horizontal sync signal.

Figure 1-10
Signal process in deflection circuit



The power requirement of the horizontal deflection circuit is about 100 times greater than the vertical deflection circuit. A high-performance power circuit using a combination of a high-power output transistor and a damper diode is used to improve the efficiency and to meet the power requirement of the horizontal deflection circuit.

The flyback transformer (FBT) in the horizontal deflection circuit serves as a high-voltage supply for the anode of the colour CRT and as a power supply for several other circuits.

Colour reproduction circuit

As shown in Figure 1-1, the colour reproduction circuit consists of two sections: the colour demodulator and the colour sync circuit. The colour reproduction circuit has the following functions: a) It takes out the colour signal from the composite colour video signal; b) It demodulates and amplifies the chroma signal; and c) It supplies the colour or the colour-subtraction signal to the CRT.

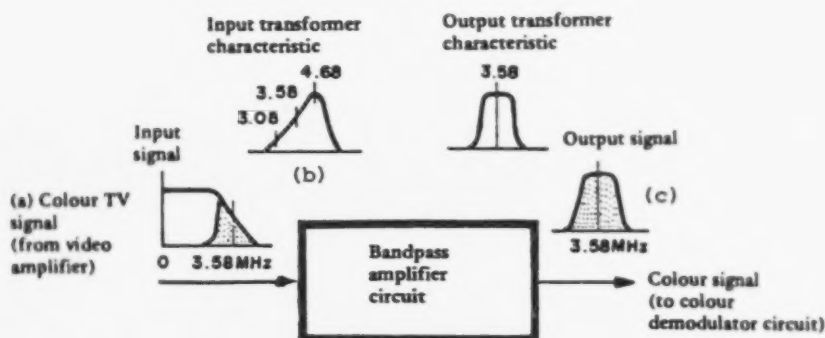
Colour demodulator section. The colour or chroma demodulator includes the bandpass amplifier, as well as the chroma demodulator and the chroma amplifier circuits.

Bandpass amplifier circuit. The bandpass amplifier consists of one or two stages tuned to 3.58 MHz with a bandwidth of ± 500 kHz. The input signal is the composite colour video signal taken from the output of the video pre-amplifier circuit. Since this amplifier is tuned to 3.58 MHz, its output consists only of the amplified 3.58 MHz chroma and burst signals. The output is coupled to the chroma demodulator and burst separator circuits. The chroma demodulator demodulates the colour information for the image; the burst separator takes out the burst signal for the synchronisation of colour.

Besides amplifying the chroma signal, the bandpass amplifier circuit compensates for the frequency distortion of the chroma signal. This distortion is due to the frequency response of the video amplifier as shown in Figure 1-11(a). The video amplifier has higher attenuation at higher frequencies of the composite video signal, where the colour information (chroma signal) is located. This results in uneven amplification of the chroma signal contained in the output of the video amplifier. Since the input signal of the bandpass amplifier is the output of the video amplifier, the bandpass amplifier uses a special input transformer tuned to 4.68 MHz with a frequency response shown in Figure 1-11(b). As shown in Figure 1-11(c), the uneven amplification of the chroma signal is compensated by this transformer.

The bandpass amplifier circuit is also associated with the ACC (automatic colour control) and colour killer circuits. The ACC automatically controls the saturation of the colour; the colour killer circuit disables the chroma-reproduction circuit when a black-and-white transmission is received.

Figure 1-11
Signal process in bandpass amplifier circuit



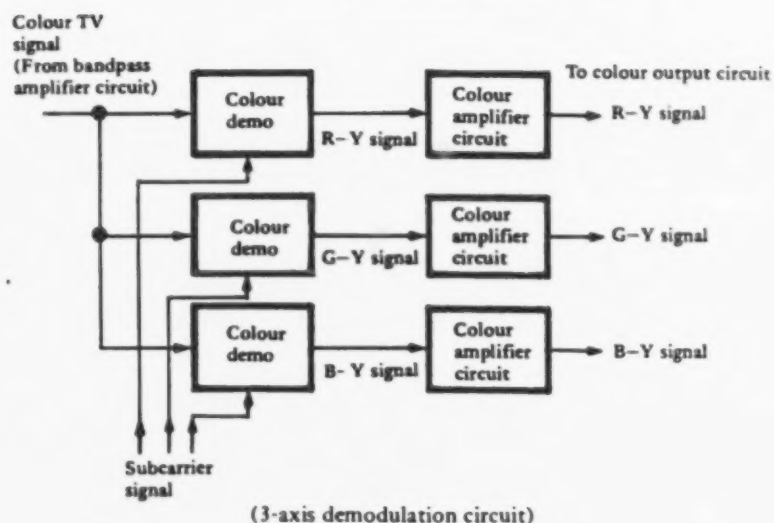
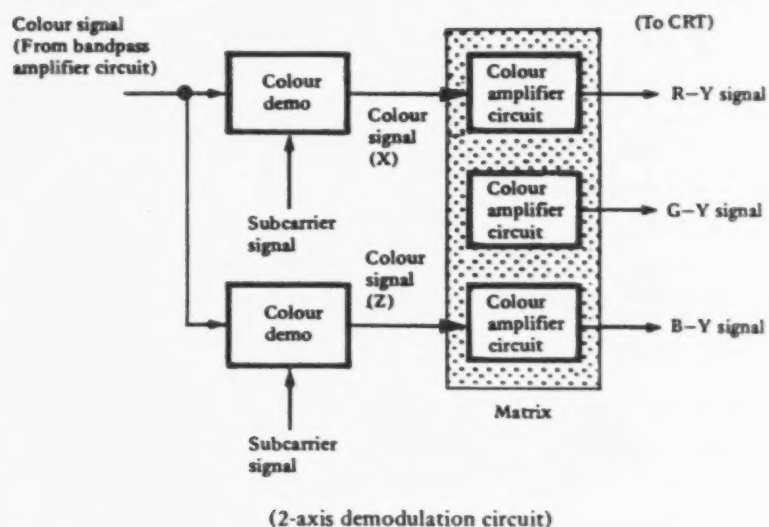
Chroma demodulator and amplifier circuits. The chroma signal is transmitted with its carrier signal suppressed at the transmitter. With this type of transmission, the chroma signal cannot be demodulated by an ordinary detector circuit. A special kind of demodulator circuit is needed to demodulate the colour information from the chroma signal.

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The two kinds of chroma demodulator circuits commonly used are the 2-axis (X, Z) demodulator and the 3-axis (R-Y, G-Y and B-Y) demodulator circuits. The functional block diagram of these demodulator circuits are shown in Figure 1-12. The 2-axis demodulator uses a matrix circuit whose outputs are the three subtraction signals (R-Y, G-Y, B-Y). These subtraction signals are amplified and supplied to the colour CRT.

There are two methods of supplying the colour subtraction signals to the colour CRT. One is to supply the signals directly to the CRT; the other is to mix the subtraction signals with the luminance signal which is supplied to the CRT.

Figure 1-12
Functional block diagram of a colour demodulator circuit



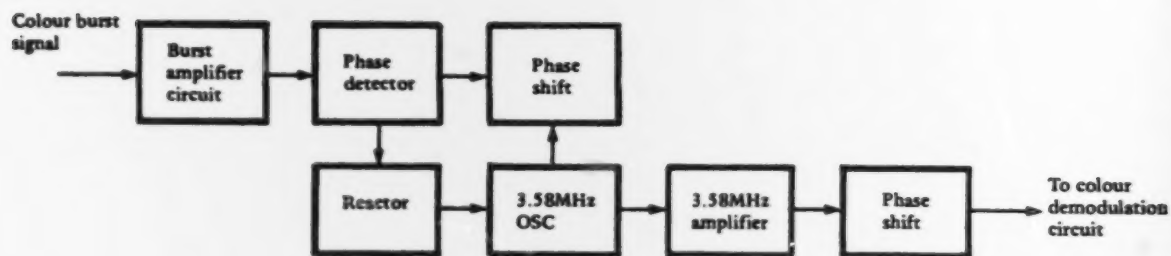
Colour synchronisation section. The colour or chroma sync section processes the burst signal and regenerates the colour subcarrier signal suppressed during transmission. The phase of the regenerated subcarrier signal is synchronised to the phase of the colour burst signal. The phase of the subcarrier signal with respect to the burst signal determines the hue of the demodulated colour signal. The colour sync section consists of the burst amplifier and the colour oscillator circuit.

Burst amplifier circuit. The burst amplifier circuit amplifies and separates the burst signal from the chroma signal. Both the chroma and burst signals have a frequency of 3.58 MHz. The burst signal, however, is present only during the horizontal blanking time. Thus, by keying on the burst amplifier circuit only during the horizontal blanking time with horizontal retrace pulses, the burst signal is amplified and separated from the chroma signal. The separated and amplified burst signal is used to synchronise the output of the colour subcarrier generator circuit with the burst signal.

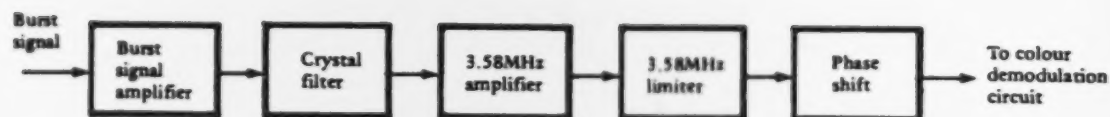
Colour subcarrier generator circuit. The colour subcarrier generator circuit regenerates the colour subcarrier signal (3.58 MHz, continuous wave) with its phase synchronised with the phase of the colour burst signal.

The colour subcarrier generator circuits commonly used are the APC (automatic phase control), the crystal filter and the burst-injection lock circuits. These three kinds of circuits are shown in Figure 1-13. The APC type is often used due to its high-precision performance. A phase-shifting circuit is placed at the output of the circuit to control the phase of the colour subcarrier signal.

Figure 1-13
Functional block diagram of a colour synchronisation circuit



(a) APC circuit



(b) Crystal-filter circuit



(c) Burst signal injection lock circuit

Sound reproduction circuit

The block diagram of a sound reproduction circuit is shown in Figure 1-1. Note that the VIF signals are supplied to the 4.5-MHz detector circuit. The output of the 4.5-MHz detector is the receiver's second IF signal, the 4.5-MHz SIF (sound IF) signal. 4.5 MHz is the difference between the video and the sound carrier frequencies. Since the sound signal is attenuated in the VIF amplifier circuit to prevent interference with the video signal, the 4.5-MHz sound signal has to be amplified by the 4.5-MHz SIF amplifier circuit. The amplified SIF signal is fed to an FM detector, since the SIF is a frequency-modulated (FM) signal. The output of the FM detector is an audio signal. The audio signal is then amplified by an AF (audio frequency) amplifier to a strength necessary to drive the speaker for sound reproduction.



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